UDC 551.515.72:551.513.2(73)"1968.12"

THE WEATHER AND CIRCULATION OF DECEMBER 1968

Strong Blocking Over the Western Hemisphere and Cold in the United States

RAYMOND A. GREEN

Extended Forecast Division, Weather Bureau, ESSA, Suitland, Md.

1. MEAN CIRCULATION

Blocking in the Western Hemisphere, which had decreased in November, came back strongly in December. The most anomalous blocking feature of the December circulation was the strong ridge over the Aleutian Islands (fig. 1) which replaced the deep Bering Sea Low of November (Stark, 1969), resulting in anomalous 700-mb height changes between months of more than 200 m. Meanwhile, the mid-Pacific trough of November moved eastward and intensified at lower latitudes, the ridge in the Rockies decreased, and the mid-United States trough broadened eastward into the Atlantic. Blocking also increased in Canada and persisted over Greenland and Scandinavia, resulting in a band of positive height anomalies from the western Pacific across Canada to northern Russia (fig. 2). South of the positive zone, height departures were negative from the eastern Pacific across the United States and from the Atlantic to the eastern Mediterranean. Although November's deep Siberian Low shifted to the Arctic Ocean at its original intensity, negative height anomalies predominated through December in Siberia.

In response to blocking, the axis of maximum 700-mb westerlies for the month (fig. 3) was south of normal over

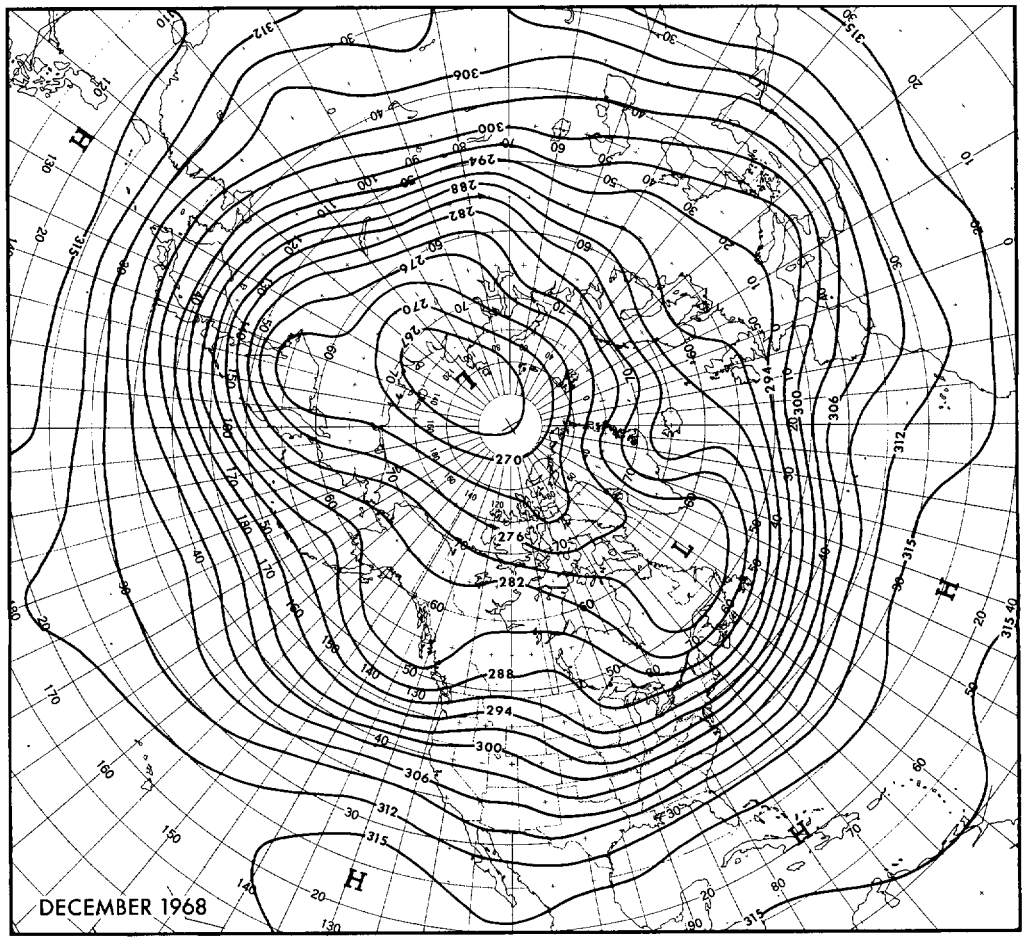


FIGURE 1.—Mean 700-mb contours (decameters) for December 1968.

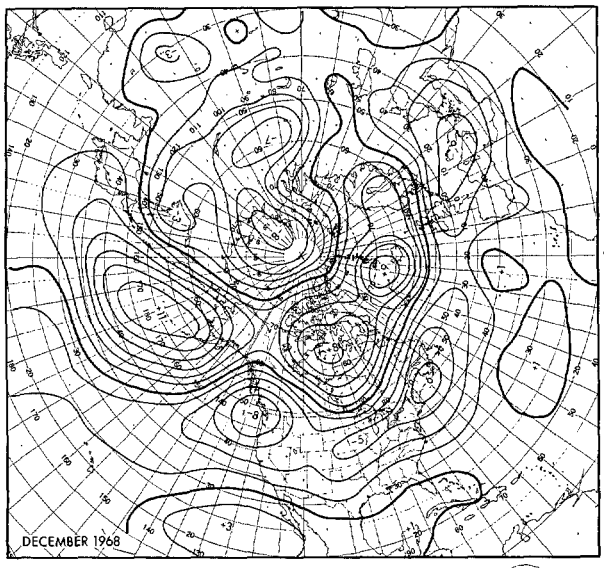


FIGURE 2.—Departure from normal of mean 700-mb height (decameters) for December 1968.

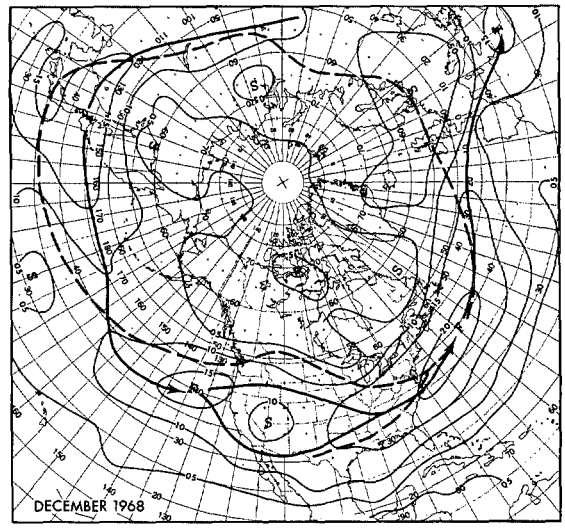


FIGURE 3.—Mean 700-mb wind speed (meters per second) for December 1968. Heavy solid lines show axes of maximum wind speed and light dashed lines the normal.

the eastern Pacific and across North America. Most storms therefore traveled southern routes, were accompanied by snow, and followed by cold. This was especially true after mid-December when blocking suddenly became pronounced.

The rate at which blocking increased shows in a plot of the 700-mb zonal wind-speed index for the Western Hemisphere (fig. 4) as a sharp decline of the temperate westerlies (35°–55°N) from 13.0 m/sec the 14th to 6.5 m/sec the 21st and a simultaneous rise in the subtropical westerlies (20°–35°N) from 5.7 m/sec to 10.4 m/sec. The extent of this evolution is further illustrated by the distribution of height changes from the first to the latter half of December (fig. 5), which shows strong rises from southern Greenland to the Gulf of Alaska and falls in the Pacific, the United States, and western Atlantic. This change field indicates that the slow-down of the westerlies in the 45° to 60°N lat. band was even greater than in the temperate zone from 35° to 55°N.

2. MONTHLY WEATHER

In accord with blocking over North America, height and temperature anomalies were predominantly negative in the United States (figs. 2 and 6). Only three cities of 100 in the standard network had temperatures in the above-normal class while 69 were below or much below. Although 21 percent (12.5 expected) were in the much-below category, new monthly records were scarce, largely because the circulation favored a warmer regime the first 2 weeks. Stampede Pass, Wash., was the single station reporting a record low average for the month. Exceptions to the general cold occurred where milder air was advected from relatively warmer bodies of water. In parts of Oregon and Idaho the moderating airmass came from the Pacific, in the Midwest from the Great Lakes, and in New England from the Atlantic. Areas that were colder than might be expected from the anomalous height flow alone included the Southwest with more than usual snow cover, and the Southeast where the abnormally cold temperatures of November persisted. In most States the downward trend of temperature was considerably stronger than usual from November to December. Of 100 representative cities, 66 were colder by one to four classes in December.

It was a stormy month as suggested by the predominance of negative height anomaly over the conterminous United States (fig. 2) and by the distribution of precipitation (fig. 7). Nearly all the northern half and parts of the southern half of the Country received more than the normal December accumulations. Table 1 lists cities from Portland, Oreg., to Portland, Maine, that had the most precipitation or total snowfall of December record. Mt. Washington, N.H., reported 103.7 in. of snowfall, the most in any month. By contrast many southern areas under fast small-amplitude westerlies were exceptionally dry; less than half the normal fell in parts of the southwestern desert area, most of Texas, and the Florida peninsula. It was the driest December of record at West Palm Beach, Fla., with .06 in.

In Hawaii the cyclonic circulation produced very heavy rainfall, especially in the northern islands. It was the wettest month of record at Lihue, Kanai, with 22.9 in., more than four times normal. At Honolulu, Oahu, the accumulation of 9.6 in. was more than three times normal.

3. WEEKLY WEATHER

DECEMBER 2–8

During the first week there was a vigorous Low in the Gulf of Alaska tenuously connected to the subtropical trough east of Hawaii (fig. 8A). A second trough extended across the eastern Great Lakes from Labrador to the Gulf of Mexico. The ridge between these troughs was stronger than normal in the western States and northern Canada but not in southwestern Canada where the negative anomaly channel joined centers in the Gulf of Alaska and the St. Lawrence Valley (fig. 8B).

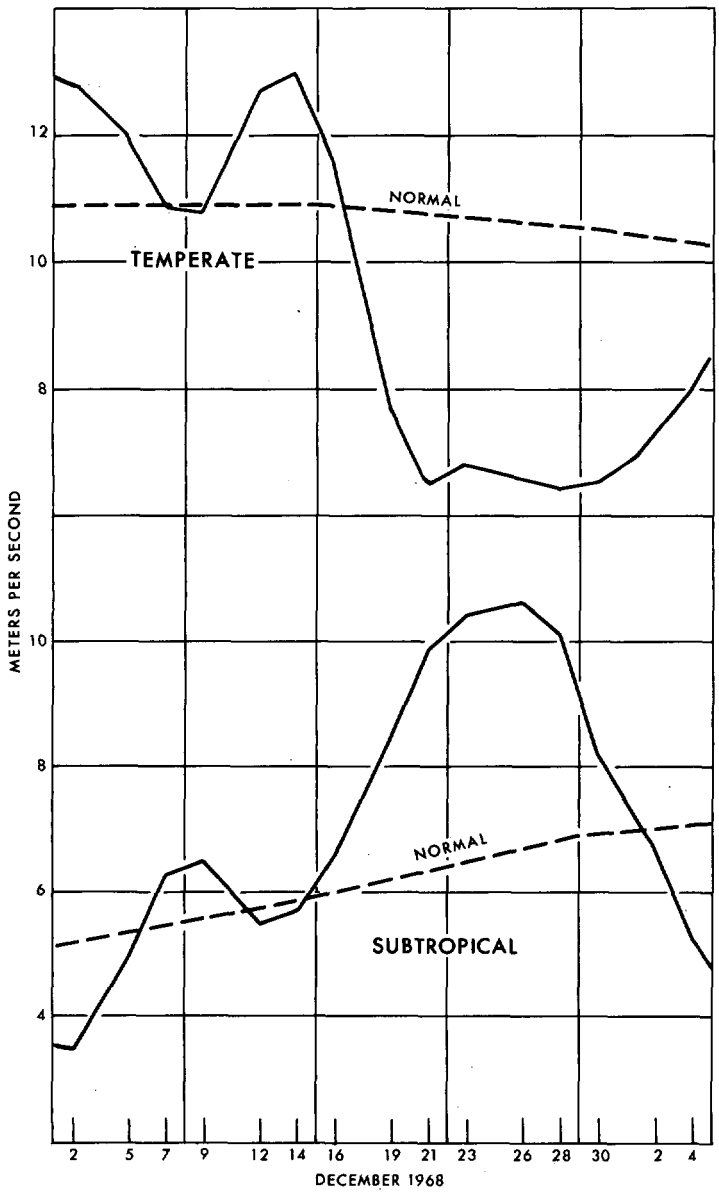


FIGURE 4.—Variation of 5-day average wind speed (zonal index) at 700 mb for the western half of the Northern Hemisphere, 20°–35°N and 35°–55°N during December 1968. Solid lines join indices at the middle of 5-day periods.

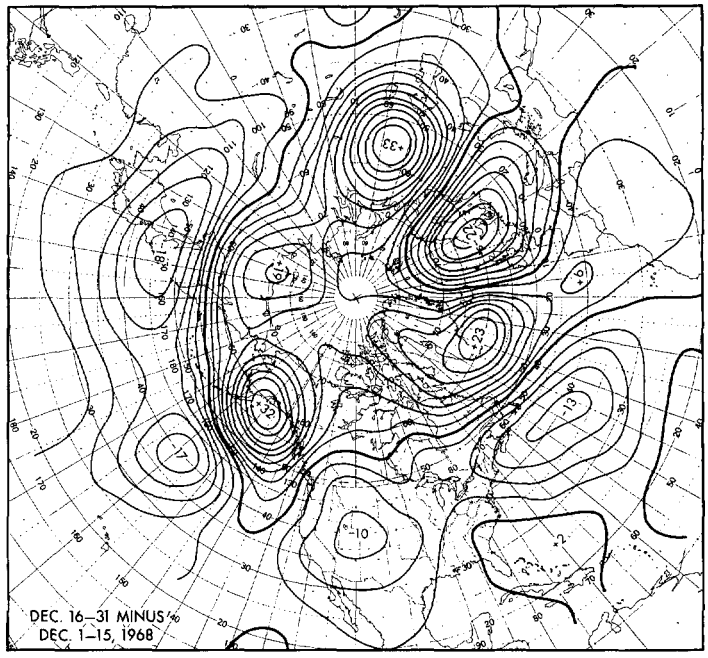


FIGURE 5.—Mean 700-mb height change (decameters) from the first half of December 1968 to the second half.

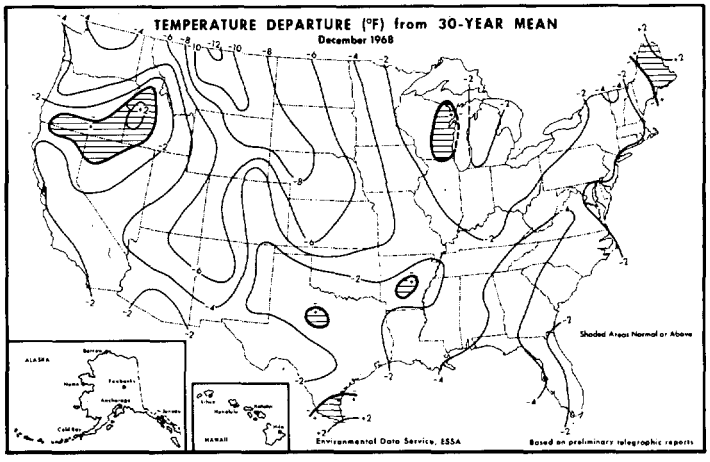


FIGURE 6.—Departure from normal of average surface temperature (°F) for December 1968 (from Environmental Data Service, 1969).

Temperatures averaged above normal beneath the mean ridge in western Montana and Idaho but mostly subnormal elsewhere under prevailing northwesterly flow (fig. 8C). California Valley fog and radiation from snow in the Rockies, often observed with high sea-level pressure in the Great Basin and central Rockies, yielded average temperatures more than 6°F below normal. Subzero daily minima were reported southward to New Mexico.

Heavy precipitation was favored by strong onshore flow in the Pacific Northwest where more than 4 in. of rain fell along the coast. Parts of the East received heavy precipitation from three storms which emerged from the Gulf of Mexico, two of which stayed west of the Appalachians on their way to the Great Lakes Region. Snow depths by the weekend were 17 in. at Greenville, Maine, and more than 20 in. locally on the lee side of Lakes Erie and Ontario. Generally light amounts were the rule elsewhere under northwesterly flow.

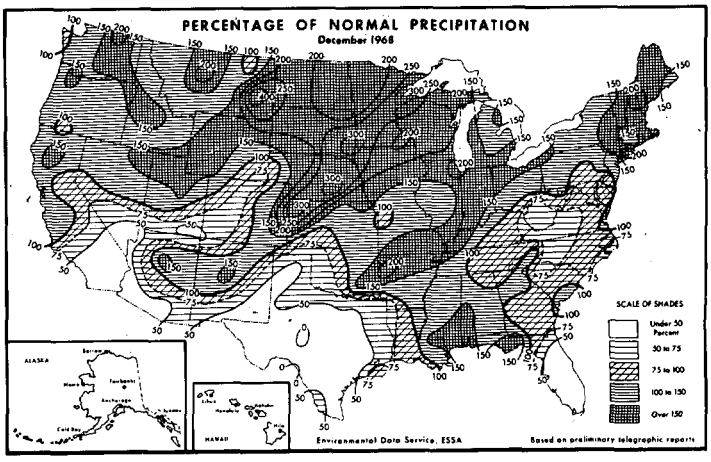


FIGURE 7.—Percentage of normal precipitation for December 1968 (from Environmental Data Service, 1969).

TABLE 1.—*Stations with most December precipitation or snowfall of record in 1968*

City	Total precipitation (in.)	Snowfall (in.)
Mt. Washington, N.H.	16.10	103.7
Portland, Oreg.	12.92	
Portland, Maine	7.70	
Concord, N.H.	5.82	
Sioux Falls, S. Dak.		41.1
Minneapolis, Minn.		28.7
Huron, S. Dak.		26.0
Marquette, Mich.	3.96	
St. Cloud, Minn.	1.95	

DECEMBER 9–15

Blocking increased from the first week to the second over North America (fig. 9A). The eastern Pacific trough intensified and advanced eastward at lower latitudes; the North American ridge progressed and changed little in the United States but retrograded and grew stronger in Canada. A new trough formed west of the previous trough over the eastern United States, which accelerated into the Atlantic and weakened.

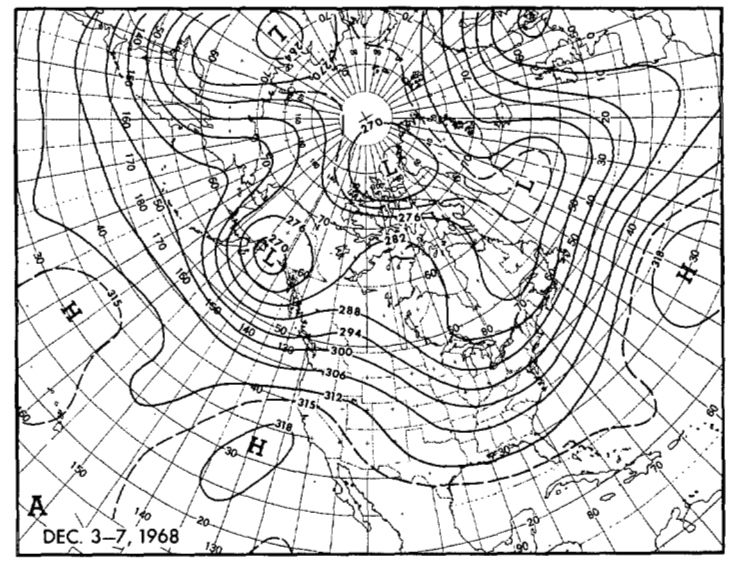
The area of above-normal temperatures expanded in the West to include more of the coastal States and the central Rockies (fig. 9C) while the coldest air, relative to normal, shifted to the Southeast where freezing occurred in Florida. Southerly winds ahead of a major storm from the Pacific brought mild weather with temperatures to 60°F as far north as New York City and Philadelphia later in the week. It was much colder behind the deep storm, which was accompanied by hurricane-force winds with gusts to 105 mi/hr at Cape Blanco, Oreg., and gusts to 60 mi/hr in the Central Plains. Subzero temperatures occurred from Montana to Minnesota and to northern New Mexico in the Rockies. At Miami, Fla., the minimum of 34°F was the coldest December temperature of record on the 16th.

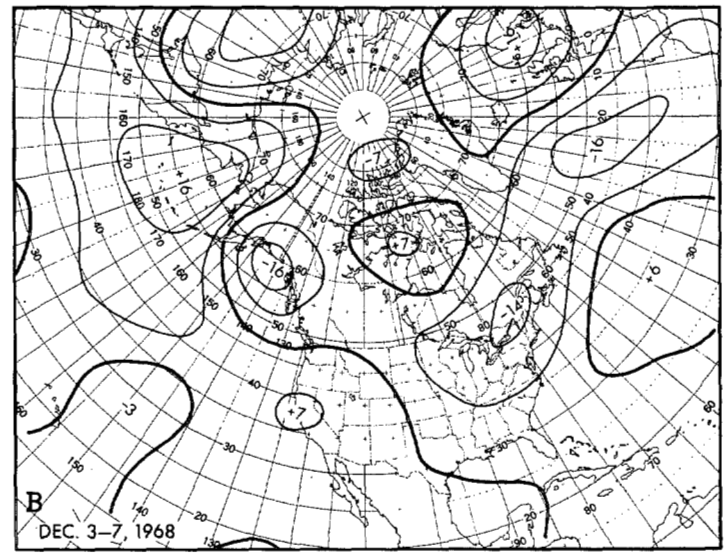
Most of the week's precipitation was associated with the single major storm. Rainfall totals ranged to more than 4 in. along the Pacific coast, and heavy snow fell in the northern and central Rockies and the Great Plains. Moisture picked up from the Gulf of Mexico ahead of the frontal trough produced rainfall of 1 to 2 in. in east Texas, Louisiana, and Mississippi. Additional moisture from the Atlantic brought similar amounts to New England.

DECEMBER 16–22

Blocking was fully established the third week over North America and nearby regions with 700-mb heights well above normal in the Gulf of Alaska and Hudson Bay (figs. 10A, B). Troughs and ridges moved a half wavelength or more from the previous week in the United States. The eastern Pacific trough came inland, the Rocky Mountain ridge shifted to the Appalachians, and the Mississippi Valley trough advanced well into the Atlantic.

Under this new circulation regime two Pacific storms took a more southerly track than before, crossed Nevada and the southern Rockies into the Texas-Oklahoma





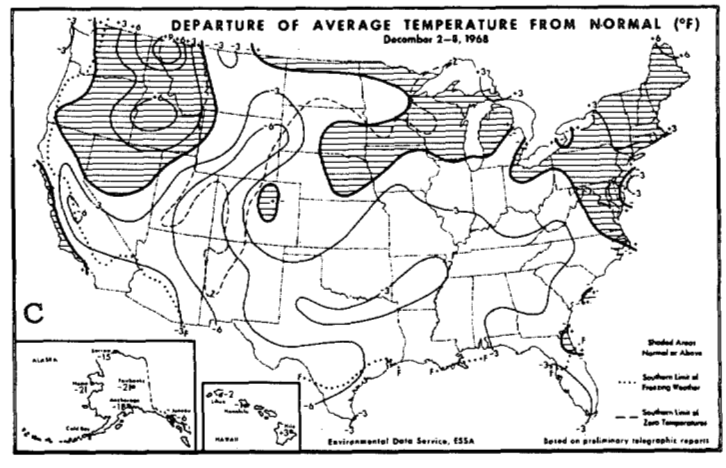
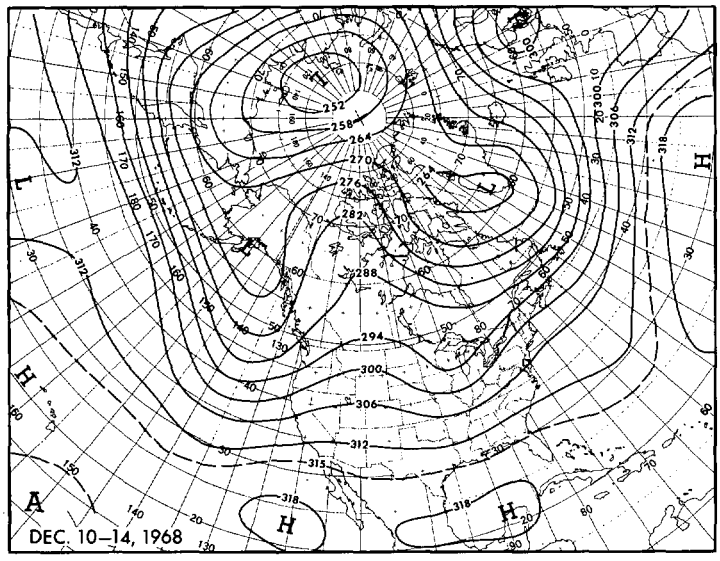
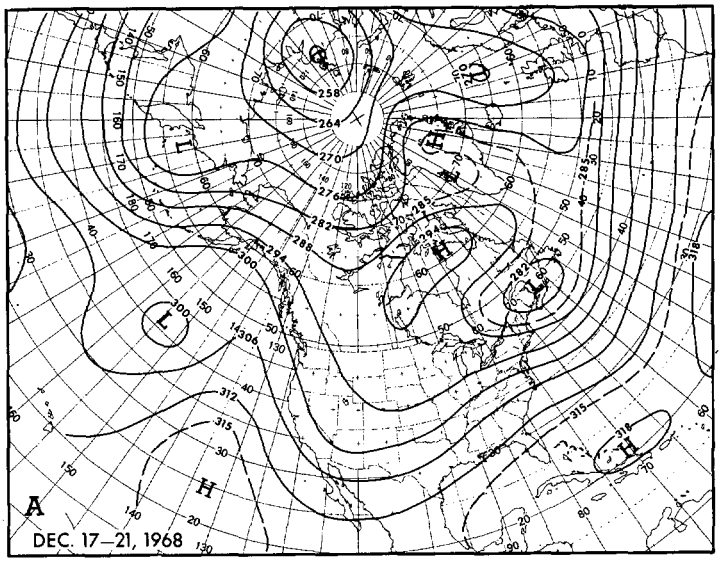
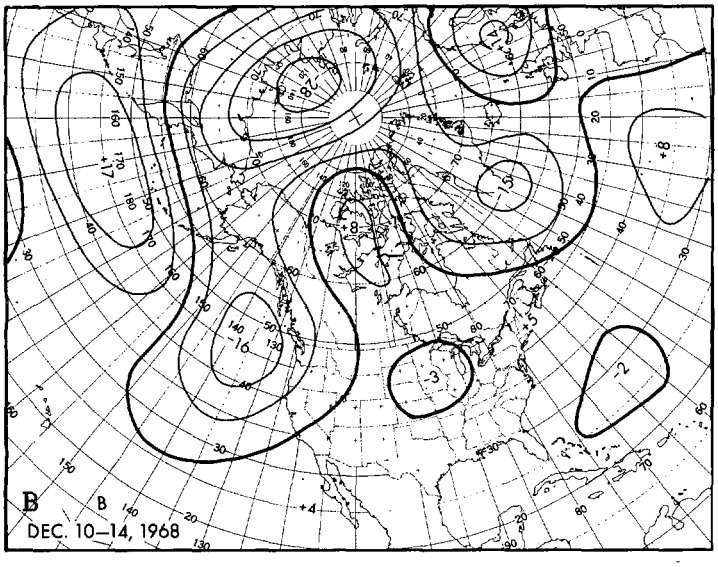


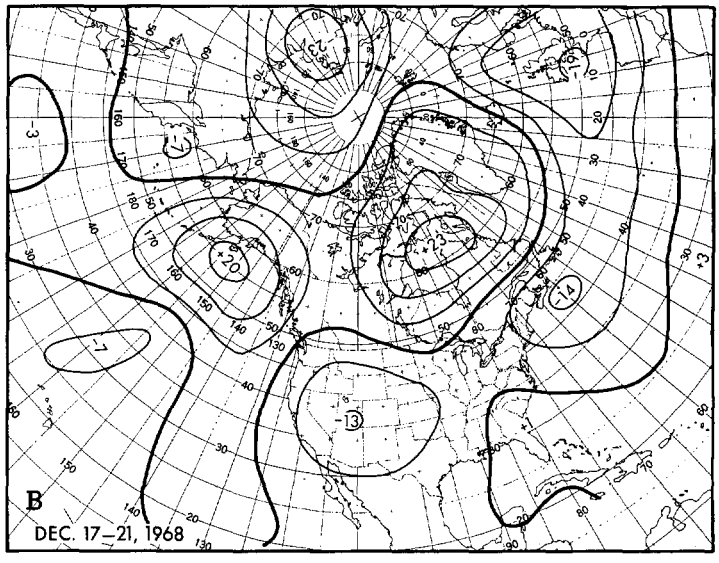
FIGURE 8.—(A) mean 700-mb contours and (B) departure from normal of 700-mb height (both in decameters) for Dec. 3–7, 1968; (C) departure from normal of average surface temperature (°F) for Dec. 2–8, 1968 (from Environmental Data Service, 1968).

Panhandle region, but thereafter curved northward west of the Mississippi River. The first storm deposited heavy snow from the Dakotas to the Texas Panhandle and eastward to the Great Lakes and the Ohio Valley. The second storm produced heavy snow over interior sections









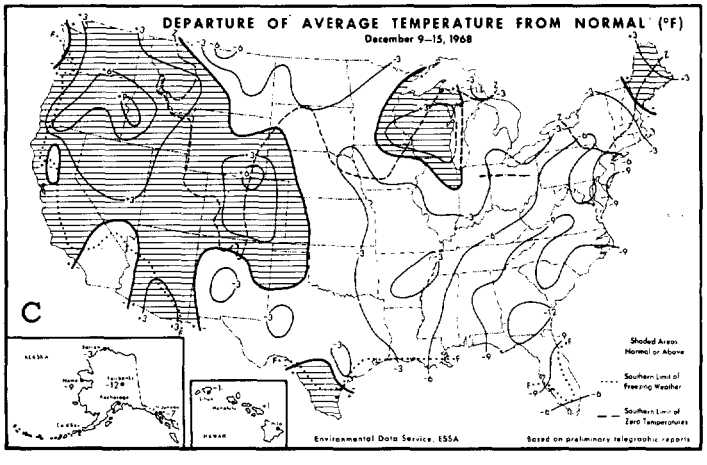


FIGURE 9.—Same as figure 8 except (A) and (B) for Dec. 10–14, 1968; (C) for Dec. 9–15, 1968 (from Environmental Data Service, 1968).

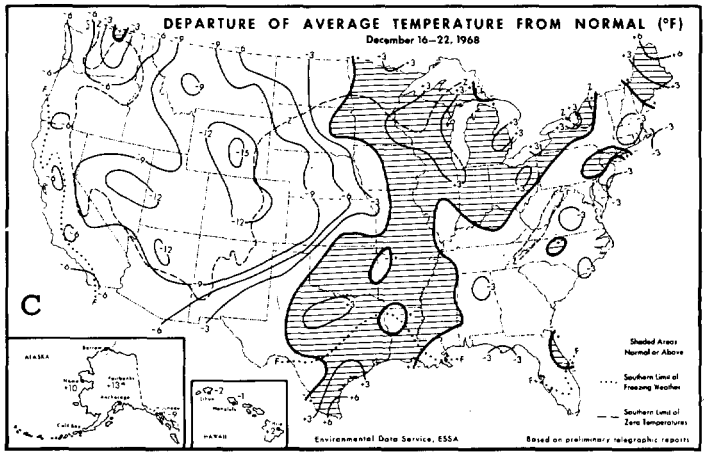
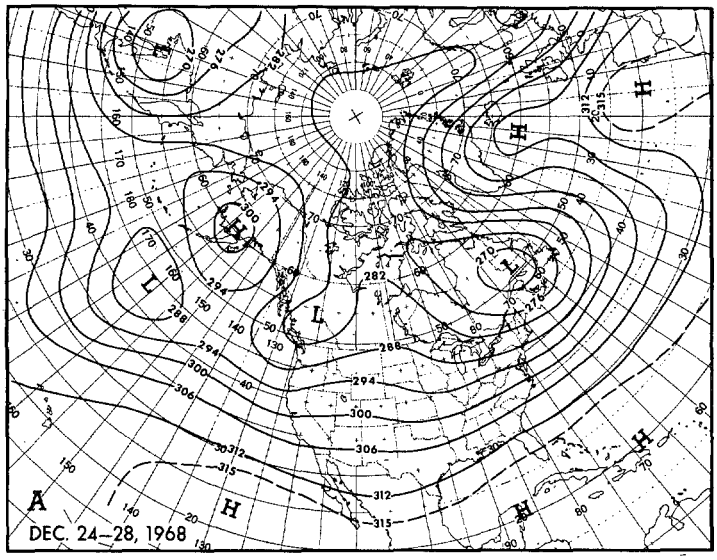
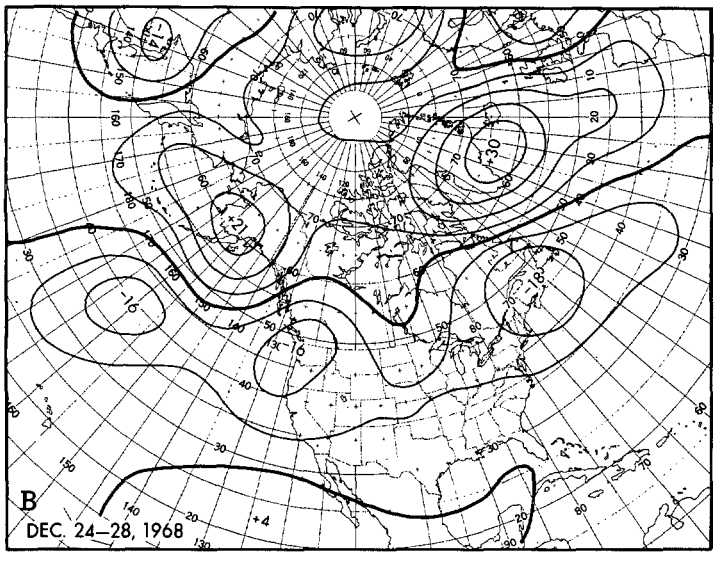


FIGURE 10.—Same as figure 8 except (A) and (B) for Dec. 17–21, 1968; (C) for Dec. 16–22, 1968 (from Environmental Data Service, 1968).

of the West, the central and southern Rockies, and the Central Plains to Upper Michigan. Blizzard conditions with 60 mi/hr winds in the Northern Plains produced drifts from 4 to 20 ft deep.

It was much colder in the West where temperatures averaged 9° to 15°F below normal over an extensive area. On the 21st Los Angeles, Calif., reported 32°F, the lowest of December record, and several new daily minima were





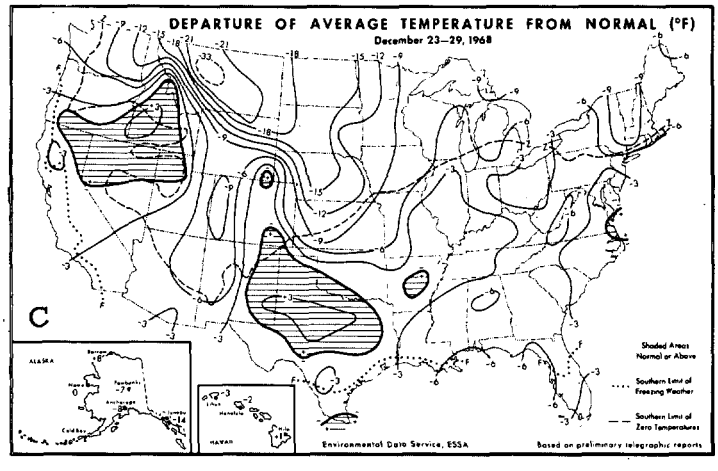


FIGURE 11.—Same as figure 8 except (A) and (B) for Dec. 24–28, 1968; (C) for Dec. 23–29, 1968 (from Environmental Data Service, 1968).

recorded during the week. Warming in the East was not strong enough to offset the earlier cold from the Southeast to southern New England where subnormal temperatures remained.

DECEMBER 23–29

Blocking continued to dominate the circulation of the Western Hemisphere during the final week. As an omega pattern developed over Alaska and the eastern Pacific, 700-mb heights fell over Canada and bordering States. In the United States the previously strong trough weakened as it moved eastward and was replaced by a ridge (figs. 11A, B).

Arctic air spilled into the East behind the departing trough and brought record low temperatures in parts of New England and adjacent States about midweek. A fresh burst of Arctic air forced southward by strong northerly flow across the Yukon and Canadian Rockies brought much colder temperatures to parts of the Northwest. On the 29th the average temperature for the day at Great Falls, Mont., was 60°F below normal. Most of Montana averaged 15° to 35°F colder than normal for the week. New daily records were established in Montana and Wyoming, and in Washington as Arctic air spilled southward west of the Divide. Elsewhere in the West, warming occurred as cold air of the previous week swept eastward.

Storm systems were poorly organized until late in the week when a wave cyclone deepened rapidly as it moved from the Southern Plains to the Great Lakes. So intense was this storm that sea-level pressures were the lowest of record at several cities from Kentucky to Michigan as it passed. Weather associated with the storm included showers and thunderstorms from Texas to the Appalachians and tornadoes from Texas to Alabama. A second storm deposited heavy snow in the Northern Rockies. One low-temperature record for December and numerous daily low-temperature records were established from the Northwest to the Northern and Central Plains the last 2 days of the month. Moscow Airport in Idaho reported −50°F, on the 30th, the coldest December temperature of record in the State. Also on the 30th, Seattle, Wash. (6°F), and Kalispell, Mont. (−35°F), reported the lowest December temperatures of record, and the record low was equaled at Pendleton, Oreg. (−12°F).

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U.S. GOVERNMENT PRINTING OFFICE: 1969—O-332-282